ter have been handled collectively as part of the introductory material. Be that as it may, the authors have managed to cover a vast amount of territory in a readily understandable manner and are to be congratulated for making many topics (e.g., 'Cowling conductivity') clear that often are poorly treated elsewhere. All in all, the book provides an excellent introduction to the subject and can be recommended for any postgraduate course in space physics. I detected only two typesetting mistakes.

If there is any criticism of the book, it must be with the manner of its translation into English. Numerous examples abound where the usage is improper (e.g., on page 9, the authors state 'a common knowledge evidence,' meaning 'a matter of common knowledge,' or on page 19, 'bear a small likeness,' meaning 'bear little likeness.' Fortunately, the mistakes are not so gross as to mask the meaning, yet it is a pity that the manuscript was not edited for such errors prior to printing. While the figures generally are excellent, the reproduction of some (e.g., VI.8 and VI.18) is so small that they are difficult to read, while that of others (e.g., 11.10 and IV.13) seems overly large.

These minor criticisms aside, *Ionospheric Techniques and Phenomena* provides a welcome addition to the literature available on the upper atmosphere and ionosphere for student and teacher alike.

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The Saturn System

Donald M. Hunten and David Morrison (Eds.), NASA Conf. Publ. 2068. NASA, Washington, D. C., vi + 420 pp., 1978.

Reviewed by David J. Stevenson

A book about the Saturn system which predates the imminent discoveries of Pioneer 11 and Voyager would seem to be premature. However, this compendium of review papers on Saturn, its satellites, its rings, and its magnetosphere is the most comprehensive available source of information on the Saturn system and amply demonstrates the essential role of ground-based observations in the planning and interpretation of in situ measurements.

This compendium arose from a NASA-sponsored workshop held in early 1978 and attended by many of the top scientists involved in studies of the major planets and their environments of particles, fields, and satellites. One major purpose of the workshop was to consider the scientific aims of SOP², which is an inevitable NASA acronym for a Saturn orbiter with dual probe (one probe for Saturn, one probe or lander for Titan). This mission has an uncertain fate in the present fiscal climate but is envisaged as utilizing a single space shuttle launch in the mid to late 1980's, with an arrival at Saturn about 6–8 years later. As Cruikshank remarks on page 338, a consideration of this mission before receiving the Voyager results is a little like sitting in the court of Queen Isabella the day after Columbus set sail and trying to figure out how to explore the Mississippi River and the Rocky Mountains. Undeterred, the participants of this workshop have presented a very convincing case for the scientific objectives of this mission.

The biggest danger confronting widespread acceptance of the importance of this mission is the mistaken suspicion that the Saturn system is rather like the Jupiter system and does not therefore merit special attention. In fact, enough is already known about the Saturn system to dispel this notion. Saturn differs in bulk composition from Jupiter in an important and significant way (it is enriched in rock or ice or both), it has a ring system quite unlike that of Jupiter or Uranus (and possibly of a different origin), it has a satellite Titan which is unique in the solar system because of its dense atmosphere and possibly 'hot' (200°K) surface, Saturn's large obliquity causes seasonal variations (Jupiter does not have readily discernible seasonal effects), its satellite morphologies may differ in important ways from the Galilean satellites because of the condensation of ammonia ice, the geometry and particle population of the magnetosphere may differ in important ways, and so on.

All of these issues (and many others) are covered either in individual papers or in the (edited) discussions which follow most of the contributions. As is frequently the case at conferences, the discussions are sometimes more revealing and interesting than the formal presentations. The main review papers are by J. B. Pollack (origin and evolution), L. M. Trafton (atmosphere), A. T. Tokunaga (thermal structure), J. Cuzzi (rings), J. J. Caldwell and D. M. Hunten (separate and very different interpretations of Titan's atmosphere), S. Chang et al. (organics on Titan), D. F. Strobel (aeronomy), M. J. Klein et al. (microwave spectrum), D. P. Cruikshank (satellites), J. W. Warwick (radio emission), and G. L. Siscoe (magnetosphere). There are also descriptions of the Voyager and Galileo missions, mission profiles and payload suggestions for SOP², an intriguing paper by J. Blamont concerning the possibility of using a self-propelled hot-air balloon (a solar or infrared montgolfier) to explore Titan's atmosphere, and several shorter presentations. Almost without exception, the contributions are clearly written with little unnecessary verbiage and a clear perspective of the important scientific issues.

I found the discussions of the rings and Titan particularly interesting and provocative. There is evidently a great deal to be learnt about the rings (on page 105, Bradford Smith refers to the outer *E* ring as remaining, in reality space, somewhere between Farrah Fawcett-Majors and Tinker Bell), especially their extent and the size distribution of particles. Even the composition is uncertain, although water ice (or, at least, a water ice coating) is favored. The sizes of the ring particles should help us to understand the condensation and collisional processes which operated in the primordial solar nebula. The uncertainties are even larger with Titan but encompass some fascinating possibilities. In various places, Titan was referred to as perhaps having an atmosphere like that of Los Angeles on a smoggy day, having methane clouds, having a tarry (organic-rich) surface, and having a surface pressure perhaps as high as 20 bars (favoring an atmospheric probe) or as low as 20 millibars (perhaps favoring a lander or hard-landing probe), the choice depending primarily on whether nitrogen is the dominant atmospheric gas. Although these uncertainties may provide headaches for probe designers, there can be little doubt that Titan would deserve a visit even if it were a separate planet, rather than attached to Saturn.

Even less is known about the smaller satellites, but

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Voyager has already taught us that the outer solar system satellites have an individuality and deserve closeup attention.

This NASA publication has a large paperback format, is inexpensively bound, and has a low price (by today's standards) typical of U.S. Government publications. Although there is little in it which cannot be found in the usual journals (especially *Icarus*), the coherent presentation in one volume makes it worthwhile reading for researchers in the relevant areas of planetary and space science. Parts of this volume are also of interest to nonspecialists who wish to learn more about upcoming and proposed NASA missions.

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Meetings

Stellar Variability and Its Consequences for the Sun

A workshop held in Tucson, Arizona, March 1–2, 1979

Attempts to understand solar change and its influence on the earth are frustrated by the brevity of our life spans. The few decades of modern solar-terrestrial data hint at secular modifications, but we can only speculate what the sun has in store for us and on what time scale. Yet the sky abounds with stars similar to the sun—some older, some younger—and through these living examples, we ought to be able to look into the future and past. This workshop assessed the technology for observing such solar-type stars (by means of precision stellar spectroscopy and photometry), considered the available evidence, and inquired as to what questions needed answers in order for scientists to decide between various proposed theoretical models of stellar/solar activity mechanisms.

By far the best spectrum indicator of activity in solar-type stars is the *H* and *K* lines of singly ionized calcium. O. Wilson presented his exploratory data showing 9–11-year time sequences of *H-K* flux for 91 main sequence, late-type stars. About a dozen solar cycle analogues have been detected, and curious secular increases (never decreases!) are commonly seen. Wilson is retiring, but a program to continue and expand on his work at Hale Observatories was described by G. Preston and A. Vaughan. Other fledgling observational efforts are developing at Lowell University, Sacramento Peak Observatory, and elsewhere.

W. Livingston and O. White reported that the *K* flux for the sun had increased 30% from solar minimum (in 1976) to date (spring 1979). Chromospheric helium (1.083μm), whose strength depends largely on coronal conditions, has increased ~100% for the same period. Weak photospheric lines suggest a spectroscopic cooling of the solar atmosphere with increased sunspot activity.

J. Hardorp noted that attempts to find an exact stellar duplicate of the sun have been unsuccessful. W. Liller and L. Hartman described how the Harvard plate archives can be employed for stellar variability studies. W. Lockwood presented the Lowell Observatory finding that planetary albedo responds to solar activity.

R. Ulrich and D. Dearborn reviewed the time scales for luminosity change predicted by models of stellar structure. Convection, being a stochastic process in operation near the stellar surface, is a likely candidate for producing short time variability on the order of days to a few years. The most 'wished for' piece of data by the theoreticians (e.g., E. Spiegel and P. Gilman) is a connection between stellar rotation rate, including differential effects, and activity cycles. Precision line profile analysis allows the deduction of rates as slow as that of the sun (2 km/sec), but the detection of differential rotation is an unsolved matter (M. Smith). The sun appears to be an abnormally slow rotator and, perhaps, a relatively inactive star. Why, we do not know. The variance in Wilson's *H-K* flux values undoubtedly has a rotation component. As the subject matures, we hopefully will learn how to sort out intrinsic luminosity, rotation, mass flux, and other unresolved spectrum modulators. Solar/stellar variability appears to be a fertile topic in its infancy.

This meeting report was prepared by W. C. Livingston of the Kitt Peak National Observatory, Tucson, Arizona.